COMPUTER SIMULATION OF CYCLIC BEHAVIOR OF RC BUILDING INTERIOR BEAM-COLUMN JOINTS

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Abstract

This study explores the capabilities of nonlinear finite element models for estimating joint cyclic rotation and shear capacities. ANSYS nonlinear finite element program is used to model RC building interior beam-column joints. The reinforced concrete modeling is calibrated using the published experimental test results. Through a parametric study the effects of variables namely (a) column axial load, (b) concrete compressive strength, (c) beam cross-sectional dimensions, and (d) amount of joint transverse reinforcement are estimated on joint cyclic behavior. Joint cyclic response measures determined from hysteresis curves and their back-bone curves are joint shear strength, joint rotational ductility, and joint energy dissipation.

Keywords: RC beam- column joints, Joint shear strength, Joint hysteresis, Cyclic response, ANSYS.

1. INTRODUCTION

Loma Prieta (1989) and Northridge (1994) earthquakes showed the vulnerabilities of beam-column and column-footing joints. However, until very recently little attention has been paid to the performance or design of joints. Beam-column joints required special attention in seismic design of reinforced concrete moment resisting frames. However seismic behavior of RC beam-column joints are more complicated than main building members due to complexity of joint demand forces, joint reinforcement detailing, joint dimensions and layout, and cyclic material behavior.

There are, potentially, a large number of parameters affecting joint capacity, and their full effect on joint behavior is still not fully understood. Main parameters for joint shear behavior were grouped by material property, joint panel geometry, reinforcement confinement, column axial load, and reinforcement bond condition. The behavior of beam-column connections, however, is complex, with a large number of variables interacting such that even an extensive experimental program cannot fully cover all combinations of these variables. A nonlinear finite element analysis provides a powerful tool to investigate the different parameters influencing the behavior and strength of beam-column joints. The ANSYS finite element program [1] was used in this study to simulate the behavior of the two experimental beam-column joints. The model has been calibrated using the results of Dhakal's tests [2]. Then a parametric study was conducted to evaluate the effects of the main variables on gravity designed joint behavior.

2. FINITE ELEMENT MODELING

2.1 ELEMENT TYPES

Reinforced Concrete - An eight-node solid element, Solid65, is used to model the concrete matrix. The element is capable of plastic deformation, cracking in three orthogonal directions, and crushing. Three different uniaxial materials, capable of tension and compression only, may be used as a smeared reinforcement, each one in any direction. Plastic behavior and creep can be considered in the reinforcing bars